P036256/WO/1
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Device for forming a peripherally closed hollow profiled element by means of fluidic internal high pressure

The invention relates to a device for forming a peripherally closed hollow profiled element by means of fluidic internal high pressure according to the preamble of patent claim 1.

A generic device is known from DE 199 05 849 C1. The device described there comprises an internal high pressure forming die, in the forming space of which a hollow profiled element can be laid, while the peripherally closed hollow profiled element is to be expanded into a final form by means of fluidic internal high pressure during the closing of the internal high pressure forming die. The device comprises, furthermore, an axial plug, by means of which the hollow profiled element is to be sealed off on the end face and which possesses an axial passage duct, via which a pressure fluid can be introduced into the hollow profiled element interior for expansion. The plug head of the axial plug, said plug head penetrating into the hollow profiled element according to figure 5 and figure 7, is designed as an elastic sealing body and consists of polyurethane. The elastic sealing body has, on its end face, a trough-like depression, of which the peripheral wall projecting into the hollow profiled element can be spread radially elastically, during the expansion process, by means of a pressure fluid, until it comes to bear sealingly against the inner wall of the hollow profiled element. If, then, an axial plug designed in this way is pushed into the hollow profiled element, the sealing body of the axial plug comes unavoidably into contact with the sharp inner edge, often having metal chips, of the hollow profiled element end, so that the sealing body is

damaged simply even when being pushed into the hollow profiled element. Further damage to the sealing body occurs when the axial plug is drawn out after the expansion of the hollow profiled element has taken place. Admittedly, this problem is to some extent remedied; on the one hand, in that the sealing body has integrated into it beforehand a wearing strip which comes into contact essentially with the inner edge of the hollow profiled element end or, on the other hand, by the arrangement of a steel attachment which carries the sealing body, only its outside coming in contact with the inner edge of the hollow profiled element end. However, these measures, on the one hand, are relatively complicated in terms of production and, on the other hand, do not afford sufficient sealing off of the hollow profiled element with respect to the pressure fluid flowing into the hollow profiled element for expansion. Furthermore, the wearing strip and that part of the steel attachment which comes in contact with the hollow profiled element are likewise subjected to wear, thus leading to a failure of sealability after multiple use of the axial plug.

The object on which the invention is based is to develop a generic device to the effect that its sealability is maintained permanently.

The object is achieved, according to the invention, by means of the features of patent claim 1.

By the plug, on the one hand, and the sealing body, on the other hand, being designed according to the invention, the latter is sufficiently protected from contact with the inner edge of the hollow profiled element end by that projection of the plug head which is formed by the annular collar of the latter, when the plug head is being pushed into the hollow profiled element. In the pushed-in position of the axial plug,

the annular collar lies with only slight play within the hollow profiled element, so that it is possible that the annular collar comes briefly into contact with the hollow profiled element end when the axial plug is pushed in. Since the annular collar does not necessarily have to implement the provisional sealability of the axial plug, but, instead, this is fulfilled by a radially projecting stop, adjoining the annular collar, of the axial plug, the wear on the annular collar which may occur due to contact with the hollow profiled element end is only marginal. Thus, in the position of use of the axial plug, the annular collar lies within the hollow profiled element, without a press fit, which is known from the prior art, being formed between said annular collar and the hollow profiled element end. By the sealing body being designed as a sealing ring, the latter can be mounted in a simple way on the plug head. Moreover, it can easily be exchanged when this is considered necessary in the case of different hollow profiled elements. It is therefore not necessary to employ a different axial plug in each case for each intended use, that is to say for different hollow profiled elements having a different diameter or cross section. The outlay in terms of apparatus for the device according to the invention is therefore simplified considerably. Owing to the protection afforded to the sealing ring by the annular collar, the sealability of the axial plug and consequently of the device is maintained permanently.

In a preferred development of the invention as claimed in claim 2, the margin of the annular collar narrows conically toward the end face of the plug head. This gives rise within the hollow profiled element, behind the sealing ring, to an annular chamber into which the pressure fluid entering the hollow profiled element via the axial passage duct of the axial plug can partially flow past the sealing ring. This gives rise to a

suction action on the sealing ring, with the result that the peripheral wall of the latter is spread open more quickly.

In a particularly preferred embodiment of the invention as claimed in claim 3, the sealing ring is supported on the end face of the annular collar. As a result, the sealing ring acquires particularly reliable large-area bearing contact and is fixed on the plug head on one side in the axial direction against slipping out of place. The end face at the same time forms a stop for the sealing ring, so that the sealing ring acted upon by the flow can spread open.

In a further preferred development of the invention as claimed in claim 4, the sealing ring is supported on its depression bottom, in the direction of the end face of the plug head, by means of a positioning ring which is embedded in a groove of the extension. As a result of the arrangement of the positioning ring, the sealing ring is fixed axially with respect to the end face of the plug head.

In a further preferred development as claimed in claim 5, a spacer ring is arranged between the positioning ring and the depression bottom of the sealing ring. By virtue of the arrangement of a spacer ring, not only can the positioning ring and consequently the sealing ring be mounted more simply in its fixing, but it is then also possible, during mounting, to press the sealing ring against the annular collar via the spacer ring and, after the positioning ring has been embedded in the groove of the extension, to leave the sealing ring in its prestressed position. What is achieved by the sealing ring being pressed against the annular collar is that the pressure fluid, which, when it flows into the hollow profiled element, flows for a short time around the sealing ring, cannot penetrate into the

gap between the sealing ring and the annular collar of the plug head and consequently undermine the sealability of the sealing ring.

In a further advantageous embodiment of the invention as claimed in claim 6 an annular bead, which projects radially beyond the entire annular collar of the plug, is formed on the outside of the sealing ring. By means of the annular bead, which has a slight oversize with respect to the inside diameter of the hollow profiled element, provisional sealing off is achieved even when the axial plug is being pushed into the hollow profiled element, since the annular bead can bear elastically against the inner wall of the hollow profiled element. Although the annular bead undergoes specific wear when it penetrates into the hollow profiled element since it comes into contact with the inner edge of the hollow profiled element, the sealabilty of the sealing ring as a whole is not adversely affected, since the wear does not encroach upon the actual sealing ring. Owing to this provisional sealing off, when the pressure fluid flows into the hollow profiled element interior there is no leakage which could escape from the gap occurring during bearing contact between the stop of the plug body and the hollow profiled element.

In a further preferred embodiment of the invention, on the outside of the sealing ring has incorporated in it, near its end face facing away from the annular collar, a peripheral groove, which receives a retaining ring possessing an elasticity identical to or deviating from that of the sealing ring. The retaining ring, which may consist of a hard material, such as, for example, polytetrafluoroethylene or the like, and is so thin that it does not come into contact with the inner edge of the hollow profiled element when the plug head penetrates into the latter and therefore does not undergo any wear, has the effect that the sealing ring

is best protected against being folded round and extruded into the gap occurring during bearing contact between the stop of the plug body and the end of the hollow profiled element. Within the scope of the invention, however, it is also conceivable that the retaining ring, which to some extent holds the sealing ring together when the latter is spread open, is actually configured such that it can assume the function of the abovementioned annular bead.

In a further preferred development of the invention as claimed in claim 8, a circular centering plate provided with eccentric passage bores and projecting peripherally beyond the sealing ring radially is arranged, with a central leadthrough, on the extension, so as to precede the sealing ring toward the end face of the plug head. The arrangement of the centering plate has an advantageous effect in the case of nonround tubes, in that it is introduced into the hollow profiled element virtually as a protective shield in front of the sealing ring and at the same time centers the axial plug within the nonround tube. The sealing ring consequently cannot come into wearing contact with the hollow profiled element. The eccentric passage bores are intended to allow the introduced pressure fluid to flow onto the sealing ring, so that the latter can exercise its spreading-open movement and therefore its sealability.

The invention is explained in more detail below by means of several exemplary embodiments illustrated in the drawings in which:

fig. 1 shows a lateral longitudinal section through a detail of an axial plug of a device according to the invention, in the position of use within the hollow profiled element,

fig. 2 shows a lateral longitudinal section through the axial plug from figure 1, with an annular bead formed on a sealing ring of the axial plug,

fig. 3 shows a lateral longitudinal section through the axial plug from figure 1, with a retaining ring embedded on the outside on a sealing ring of the axial plug,

fig. 4 shows a lateral longitudinal section through the axial plug from figure 1, with a centering plate preceding a sealing ring of the axial plug on the end face.

Figure 1 illustrates a device for forming a peripherally closed hollow profiled element 1 by means of fluidic internal high pressure, said device containing an internal high pressure forming die 2, in the forming space 3 of which the hollow profiled element 1 is laid. The device contains, furthermore, at least one axial plug 4 for sealing off the hollow profiled element 1 on the end face. The axial plug 4 possesses a centrally running axial passage duct 5 which supplies pressure fluid to the hollow profiled element 1 and which is connected at an end 6 facing away from a hollow profiled element to a fluid high pressure generation system conveying the pressure fluid and which issues on the end face 7 of its plug head 8 penetrating into the hollow profiled element 1 in the position of use. The plug head 8 capable of being pushed into the hollow profiled element 1 is rigidly connected to the remaining plug body 9 of the axial plug 4 and is formed by an annular collar 10 shaped out on the axial plug 4 and by a narrowed extension 11 adjoining said annular collar toward the end face 7 of the head 8. The extension 11 is arranged centrally and has the passage duct 5 passing through it. The axial plug 4 has, furthermore, on its plug body 9, a radially

peripheral stop which, in the position of use of the axial plug 4, bears against the closing edge 12 of the hollow profiled element end 13. The stop is formed here by the end face 14 of a sleeve 15 screwed onto the plug body 9 or fastened to the plug body 9 in another way. For positioning the sleeve 15 during mounting on the plug body 9, the end face 14 of said sleeve butts against the rear side 16 of the annular collar 10.

The axial plug 4 carries a sealing body which is designed as a sealing ring 17 pushed or slipped onto the extension 11 of the plug head 8. In this case, the sealing ring 17 is supported on the end face 18 of the annular collar 10, said end face facing the hollow profiled element 1. The sealing ring 17, spreadable in a radially elastic manner, consists, for example, of an elastomer or polyurethane. It has, on its end face 19 facing the hollow profiled element 1, a trough-like depression 20, the peripheral wall 21 of which, by means of the inflowing pressure fluid, undergoes the spread within the hollow profiled element 1 until it comes to bear sealingly against the inner wall 22 of the hollow profiled element 1. The sealing ring 17, furthermore, is supported on its depression bottom 23, in the direction of the end face 7 of the plug head 8, by means of a positioning ring 24 which is embedded in a groove 25 of the extension 11. Moreover, a spacer ring 26 is arranged between the positioning ring 24 and the depression bottom 23 of the sealing ring 17. By support by means of the positioning ring 24 and the spacer ring 26, on the one hand, and by support on the end face 18 of the annular collar 10, the sealing ring 17 is fixed axially to the plug head 8. The outside diameter of the sealing ring 17 is selected such that it lies with some play within the hollow profiled element 1 in the position of use of the axial plug 4. Furthermore, the outside diameters of the outside 27 of the sealing ring 17 and of the margin 28 of the annular

collar 10 are coordinated with one another such that the latter projects peripherally beyond the sealing ring 17 at at least one point in the radial direction. That is to say, on the annular collar 10, there is at least one point which is peripherally larger radially than the entire outside 27 of the sealing ring 17. The margin 28 of the annular collar 10, moreover, narrows conically toward the end face 7 of the plug head 8, thus forming, between the margin 28 of the inner wall 22 of the hollow profiled element 1 and the rear side 29, supported on the annular collar 10, of the sealing ring 17, a small annular chamber 30 into which a part quantity of the pressure fluid can briefly flow during filling.

If, then, the hollow profiled element 1 is filled via the passage duct 5 of the axial plug 7 with the pressure fluid conveyed by the fluid high pressure generation system, said pressure fluid flows in back stroke into the depression 20 of the sealing ring 17, with the result that, on account of the flow pressure on the peripheral wall 21 of the elastic sealing ring 17, the latter spreads open until said wall is pressed against the inner wall 22 of the hollow profiled element 1. At the same time, as already mentioned, a part quantity of pressure fluid flows past the sealing ring 17 into the chamber 30, with the result that a suction action occurs which assists the spreading of the sealing ring 17 and consequently accelerates sealing off during filling. The trough shape of the depression 20 serves in this case for a better conversion of the flow force of the inflowing pressure fluid into a radial spreading movement of the peripheral wall 21 of the sealing ring 17. If, then, the hollow profiled element 1 is formed, the pressure fluid is put under high pressure, with the result that the peripheral wall 21 of the sealing ring 17 is pressed to an extreme extent against the inner wall 22

of the hollow profiled element 1, so that a sealing off of the hollow profiled element 1 which is tight to fluid high pressure is ensured outwardly.

A variant of the invention is shown in figure 2. In this case, on the outside 27 of the sealing ring 17, an annular bead 31 is formed, which projects radially beyond the entire annular collar 10 of the plug 4 and which is located near the end face 19 of the sealing ring 17. The annular bead 31 may be injection-molded onto the sealing ring 17 at a later stage or else be shaped at the same time as the production of the latter. On account of the annular bead 31, sealing off is afforded even during the penetration of the axial plug 4 into the hollow profiled element 1 before the filling operation.

In a further variant of the invention according to figure 3, contrary to the variants of figures 1 and 2, the outside 27 of the sealing ring 17 has incorporated in it, near its end face 19 facing away from the annular collar, a peripheral groove 32 which receives a retaining ring 33 possessing a lower elasticity than the sealing ring 17. If there is an oversize of the retaining ring 33 with respect to the diameter of the inner wall 22 of the hollow profiled element 1, the retaining ring 33, preferably designed as a quad ring or O-ring, assumes the provisional sealing function at the commencement of the filling process. By virtue of its contracting action on the sealing ring 17, the retaining ring 33 gives the sealing ring 17 better protection against being folded round and extruded into the interspace between the plug head 8 and the inner wall 22 of the hollow profiled element 1.

In contrast to the preceding exemplary embodiments, in a variant of the invention according to figure 4, the extension 11 has arranged on it a centering plate 34

which peripherally projects radially beyond the sealing ring 17 and the annular collar 10. The centering plate 34 precedes the sealing ring 17 toward the end face 7 of the plug head 8 and is fastened to the extension 11 by means of a central leadthrough 35, and, for mounting, it is advantageous if, as here, the centering plate 34 can be screwed onto the extension 11. So that the introduced pressure fluid can flow onto the sealing ring 17 in spite of the preceding centering plate 34, with the result that the spreading movement can take place, eccentric passage bores 36 are formed in the circular centering plate 34.

In all the abovementioned variants, it is additionally conceivable that one or more radial ducts, which issue into the depression 20 of the sealing ring 17, branch off from the passage duct 5 of the axial plug 4 at the location of the depression 20. The peripheral wall 21 of the sealing ring 17 can thereby be acted upon, even in an early phase of the filling operation, by pressure fluid via the radial ducts as a result of a branch-off and at the same time be spread open. Very early sealing off is provided in this case.

By means of the device according to the invention, which makes it possible for the hollow profiled element 1 to be sealed off outwardly without any axial force, it is possible, as compared with seals not free of axial force, to expand hollow profiled elements 1 by means of internal high pressure and to calibrate them, without shortening the component length, since the axial force, which, when the hollow profiled element 1 is being sealed off, leads to a component-shortening thickening of the hollow profiled element end, is dispensed with. At the same time, creases are also avoided, which normally arise due to the sealing force fraction of the axial plugs in the case of seals not free of axial force. Moreover, via the sleeve 15, an

axial secondary push during forming may take place at any time, as required, during the forming process.